

***Vigisospirura potekhina hugoti* subsp. n. (Nematoda: Spirocercidae) from *Meles meles* (Carnivora: Mustelidae) in Spain**

JORDI TORRES,¹ CARLOS FELIU,^{1,2} AND JORDI MIQUEL¹

¹ Parasitology Laboratory, Department of Sanitary Microbiology and Parasitology, Pharmacy Faculty, University of Barcelona, Avda. Diagonal sn, 08028 Barcelona, Spain and

² Institut de Salut Pública, Campus Universitari de Bellvitge, Barcelona, Spain

ABSTRACT: *Vigisospirura potekhina hugoti* subsp. n. from the stomach and esophagus of *Meles meles* (Carnivora: Mustelidae) collected in Spain is described. Morphologically, the new subspecies is distinguished by the presence of a small projection (like a knob) at the end of the male and by the size of its spicules. A key for *Vigisospirura* species based on morphological and morphometric characteristics as well as chorology and host specificity is proposed. A scanning electron microscope study of the several structures is presented.

KEY WORDS: *Vigisospirura potekhina hugoti* subsp. n., Nematoda, Spirocercidae, *Meles meles*, Carnivora, Mustelidae, Spain.

Nematodes of the genus *Vigisospirura* Petrow et Potekhina, 1953, were collected from the stomach and esophagus of several eurasian badgers, *Meles meles* (Linnaeus, 1758), on the Iberian Peninsula. The specimens differed from the valid species known to date belonging to this genus. Chabaud (1959) and Wong *et al.* (1980) have considered only 5 valid species: (a) *Vigisospirura potekhina* (Petrow et Potekhina, 1953) Chabaud, 1959 (= *V. skrjabini* Petrow et Potekhina, 1953, not Tschernikova, 1934); (b) *V. grimaldiae* (Seurat, 1915) Chabaud, 1959 (= *Habronema grimaldiae* Seurat, 1915); (c) *V. skrjabini* (Tschernikova, 1934) Chabaud, 1959 (= *H. skrjabini* Tschernikova, 1934); (d) *V. whitei* (Monnig, 1931) Chabaud, 1959 (= *H. whitei* Monnig, 1931); and (e) *V. itascensis* (Chandler, 1954) Wong *et al.*, 1980 (= *Chlamydooprocta itascensis* Chandler, 1954). The aim of this study is to describe a new subspecies, *Vigisospirura potekhina hugoti*, and to present a key to the representatives of the genus *Vigisospirura*.

Material and Methods

Seventy-eight specimens of *Meles meles* from different localities in 20 provinces of the Iberian Peninsula were examined. These provinces are Asturias (AST), Barcelona (B), Burgos (BU), Cáceres (CC), Cantabria (CAN), Ciudad Real (CR), Girona (GI), Granada (GR), Guadalajara (GU), Jaén (J), La Coruña (C), León (LE), Lleida (L), Navarra (NA), Palencia (P), Salamanca (SA), Soria (SO), Tarragona (T), Valladolid (VA), and Zaragoza (Z) (Fig. 1). Some hosts were sent frozen to our laboratory; however, most of them came from the National Museum of Natural Sciences Collection (MNCN) in Madrid, where they had been preserved in 70% ethanol or 4% formaldehyde solutions.

Nematodes obtained were preserved in 70% ethanol. Some were mounted on slides in lactophenol and used in light microscopy studies. Only 9 adult males and 2 gravid females fixed in good extension were useful for measurements. Some broken male and female specimens were used to study, respectively, the caudal and cephalic regions by means of scanning electron microscopy (SEM). These specimens were prepared following the general methodology of Prokopic and Hulínková (1983), Sanmartín *et al.* (1992), and Miquel *et al.* (1995).

The specimens of *Vigisospirura* were found in 5 of the 78 eurasian badgers examined (prevalence 6.4%). Fifty-eight individual worms were collected (11 adults [9 males and 2 females], several preadults and some broken adults). Mean intensity was 11.6 (1–42) and abundance was 0.74.

Description

***Vigisospirura potekhina hugoti* subsp. n. (Figs. 2–10)**

Medium sized worms. Cuticle with transverse striations separated from each other about 11 μ m. Lateral alae absent. Buccal cavity with thick walls expands anteriorly to form ring surrounding oral opening (without buccal teeth) and outer elevated cuticular shield. Oral opening with prominent rectangular to oval cephalic shield from which delicate lateral lips and dorsoventral and median lobes arise (Figs. 2, 7). Fourteen cephalic papillae are present: 6 small inner papillae and 4 pairs of prominent submedian outer papillae (Figs. 2, 7). Amphids are located laterally near outer edge of cephalic shield (Figs. 2, 7).

MALE (holotype) (Figs. 3–5, 8–10): Body length 13.7 mm; maximum body width 260 μ m. Buccal cavity 30 μ m in length and in width. Total length of esophagus 7.0 mm (51.4% of

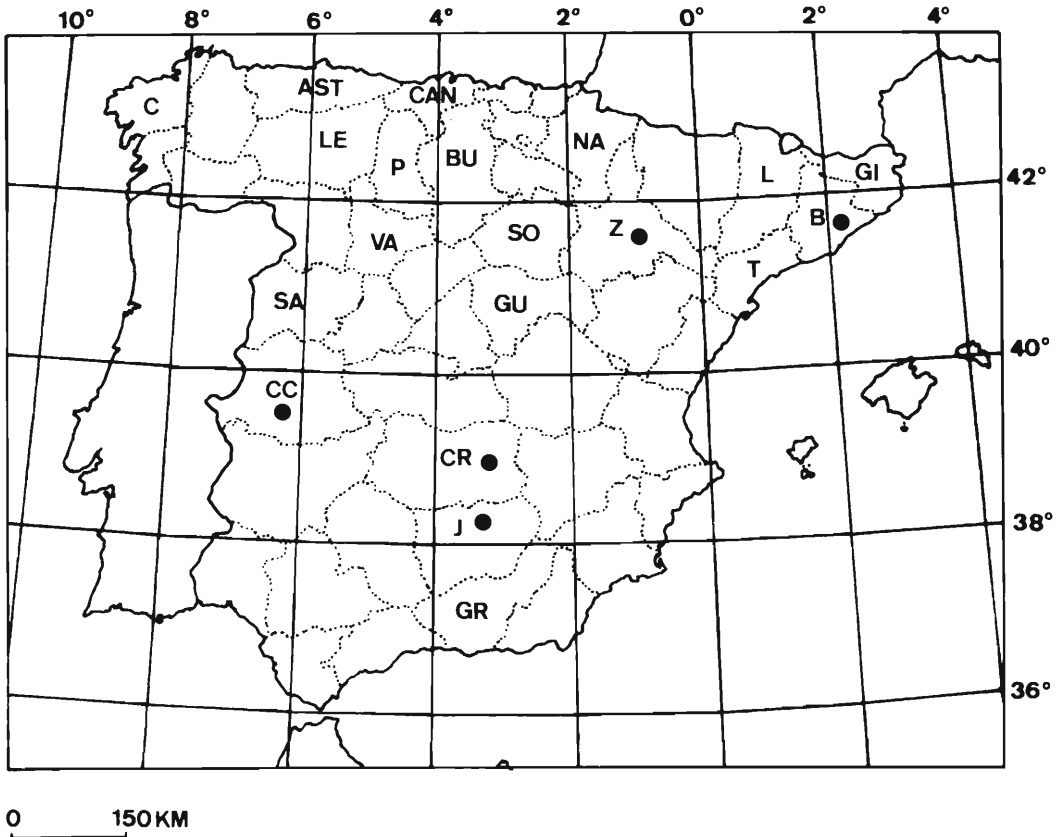
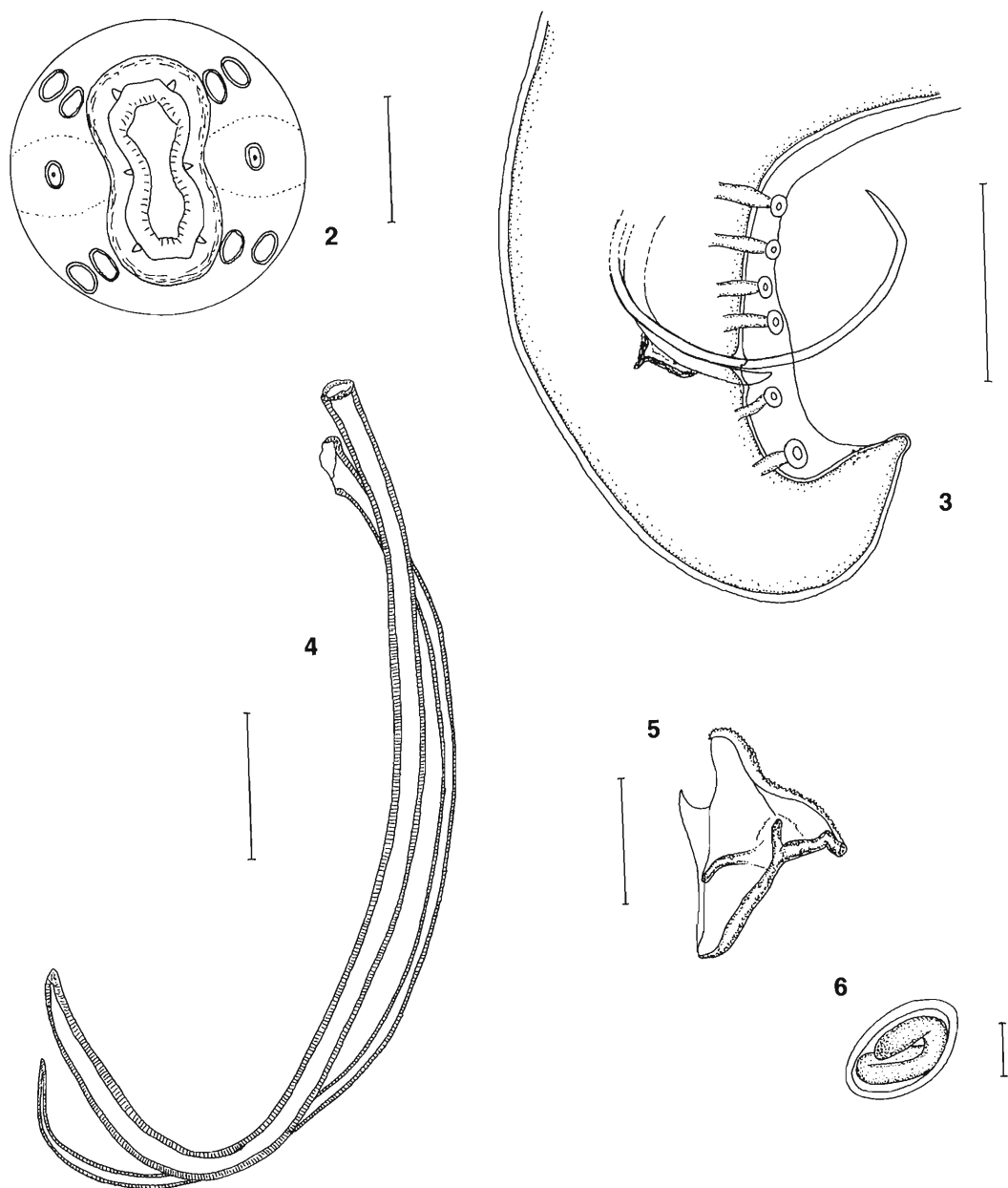


Figure 1. Provinces where *Vigisospirura potekhina hugoti* subsp. n. has been detected (●).

body length); muscular part 395 μm and glandular part 6.6 mm. Deirids, nerve ring, and excretory pore located at 231, 295, and 480 μm from the cephalic extremity, respectively. Spicules are simple, slender and arcuate in the distal end (Figs. 3, 4); right spicule 880 μm long and 13 μm in maximum width proximally; left spicule 980 μm long and 20 μm in maximum width proximally. Right spicule not attenuated distally; left spicule with an attenuated rounded apex (Fig. 4). Gubernaculum alate and complex (Fig. 5); the more chitinized part is boot-shaped on lateral view, 72 μm in length and in maximum width. Caudal end of body arcuate or coiled in the larger specimens (Fig. 3). Caudal papillae, including 6 pairs of long digitiform papillae (4 precloacal [CLP1, CLP2, CLP3, and CLP4] and 2 postcloacal pairs [CLP5 and CLP6]) and a flat median papilla, immediately anterior to anus (Figs. 3, 8, 9). Sensory area present near caudal extremity on ventral surface of tail, with 4 pairs

of tiny papillae (CLP7, CLP8, CLP9, and CLP10) and phasmids (Fig. 10). Tail 235 μm in length. Caudal extremity ending with a small projection (Fig. 3).

FEMALE (allotype) (Figs. 2, 6, 7): Body length 20.9 mm; maximum body width 415 μm . Buccal cavity 30 μm in length and 23 μm in width. Total length of esophagus 9.5 mm (45.3% of body length); muscular part 470 μm and glandular part 9.0 mm. Deirids, nerve ring, and excretory pore located at 260, 290, and 355 μm from the cephalic extremity, respectively. Vulva located at 10.7 mm from the anterior extremity (51.3% of body length). Opisthodelphic. Eggs oval with smooth thick shell, 46–57 \times 26–33 μm in size. Eggs in advanced uterine positions (near vagina) contain fully embryonated first-stage larvae (Fig. 6) and are bigger than unembryonated ones in other uterine positions. Tail 250 μm long. Phasmids located near apex of the



Figures 2–6. *Vigisospirura potekhina hugoti* subsp. n.: details of male and female specimens. 2. Cephalic extremity in apical view. 3. Lateral view of the male's caudal extremity. 4. Spicules. 5. Lateroventral view of the gubernaculum. 6. Embryonated egg. Scale bars: 2, 6 = 20 μm ; 3 = 200 μm ; 4 = 100 μm ; 5 = 50 μm .

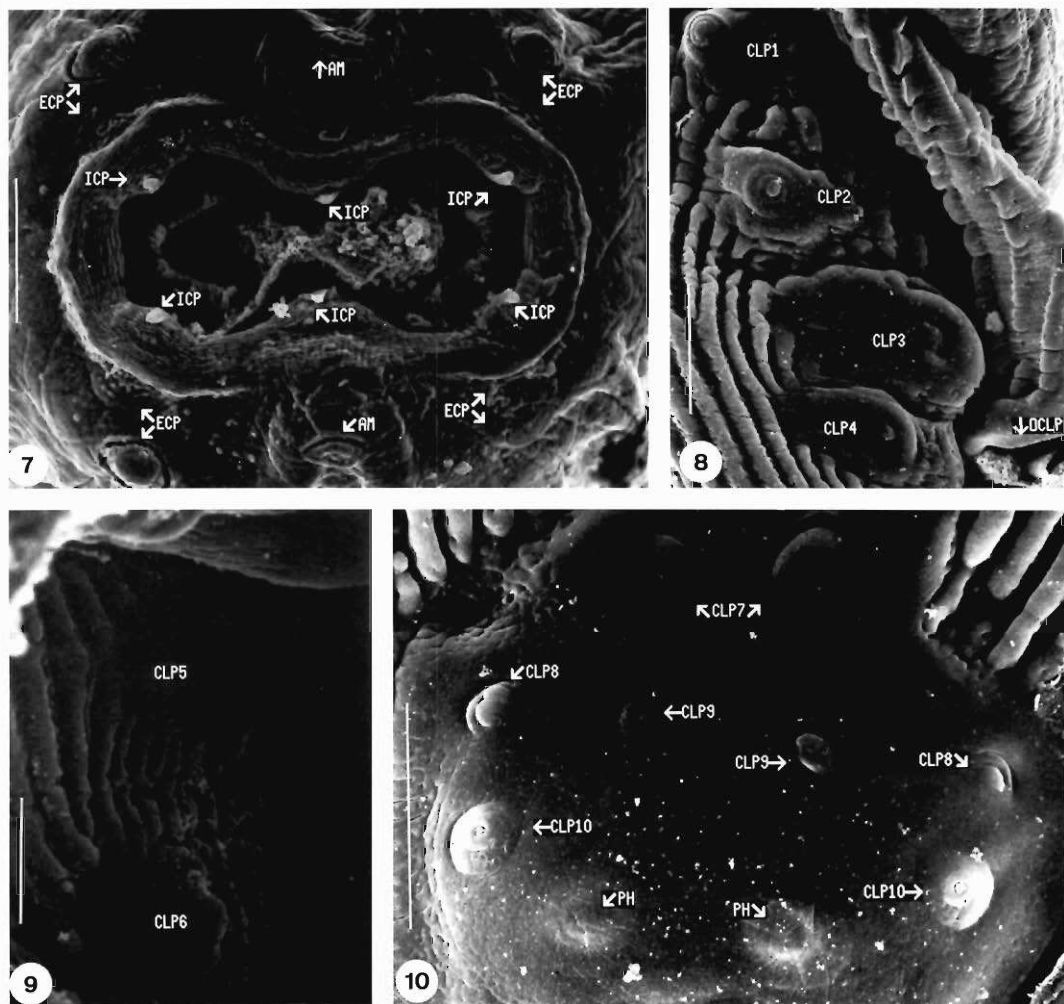
tail. Anus, broad in shape, located before 2 caudal prominent bulges.

HOST: *Meles meles* (Linnaeus, 1758).

SITES IN HOST: Stomach and esophagus.

TYPE LOCALITY: Virgen de la Cabeza (province of Jaén).

LOCATIONS: Provinces of Barcelona (B), Cáceres (CC), Ciudad Real (CR), Jaén (J), and Za-



Figures 7–10. Scanning electron microscopic observations of *Vigisospirura potekhina hugoti* subsp. n. 7. Cephalic extremity of the female, apical view. 8. Precloacal papillae. 9. Postcloacal papillae. 10. Phasmids and last postcloacal papillae group. Scale bars: 7 = 10 μ m; 8–10 = 20 μ m. AM, amphids; CLP, cloacal papillae; ECP, external cephalic papillae; ICP, internal cephalic papillae; OCLP, odd cloacal papilla; PH, phasmids.

ragoza (Z). All biotopes located between 38th and 42nd parallels (Fig. 1).

DATE OF COLLECTION: 21 August 1979 (holotype).

SPECIMENS DEPOSITED: National Museum of Natural Sciences in Madrid. Holotype, allotype, and 1 paratype (Male), MNCN 11.02/9, and 1 paratype (Male), MNCN 11.02/10. Several paratypes in Department of Sanitary Microbiology and Parasitology, University of Barcelona.

ETYMOLOGY: The new subspecies, *Vigisospirura potekhina hugoti*, is dedicated to Dr. Jean

Pierre Hugot from the Muséum National d'Histoire Naturelle of Paris (France).

Discussion

To our knowledge, species belonging to the genus *Vigisospirura* have not been found in Central or Western Europe to date. The 5 species belonging to the genus and accepted by Chabaud (1959) and Wong *et al.* (1980) show different distributions. *Vigisospirura itascensis* is only found in North America, *V. skrjabini* in Vladivostok, Russia, *V. potekhina* in North America

Table 1. Measurements (in micrometers) of *Vigisospirura potekhina hugoti* subsp. n.

	Males (n = 8 paratypes)			Female (n = 1 paratype)
	Maximum	Minimum	Mean \pm σ	Value
Body length	19,762	11,847	15,869.0 \pm 2,904.2	21,512
Maximum body width	440	227	333.7 \pm 70.8	750
Depth buccal capsule	34	26	28.6 \pm 2.7	33
Width buccal capsule	26	18	22.3 \pm 2.5	31
Deirids*	295	206	251.6 \pm 29.9	385
Nerve ring*	373	266	316.5 \pm 37.3	341
Excretory pore*	468	367	417.9 \pm 35.5	514
Esophagus				
Total length	8,824	5,863	7,612.2 \pm 1,198.3	8,968
Muscular length	534	372	461.7 \pm 63.9	493
Glandular length	8,299	5,491	7,150.2 \pm 1,137.3	8,475
Body length (%)	51.7	44.6	48.2 \pm 1.9	41.7
Right spicule	917	855	884.7 \pm 23.3	—
Left spicule	990	928	957.6 \pm 20.9	—
Gubernaculum				
Length	82	72	76.3 \pm 3.7	—
Maximum width	82	59	68.8 \pm 7.8	—
Vulva*				10,934
Body length (%)	—	—	—	50.8
Tail	283	202	230.0 \pm 27.4	326
Eggs (length)	—	—	—	46–57
Eggs (width)	—	—	—	26–33

* Distance from anterior extremity.

and the Tadzhikistan Republic (southwestern Asia), *V. grimaldiae* in Northern Africa, and *V. whitei* in Southern Africa. On the other hand, these species have been isolated as parasites of the families Canidae (*V. skrjabini*, *V. grimaldiae*, and *V. potekhina*); Felidae (*V. skrjabini* and *V. potekhina*); Viverridae (*V. whitei*), and Mustelidae (*V. itascensis* from *Mephitis mephitis* [Mephitinae] and *V. potekhina* from *Meles meles* [Melinae]).

The species can be divided into 2 groups according to the presence (*V. whitei*, *V. skrjabini*, and *V. itascensis*) or absence (*V. grimaldiae* and *V. potekhina*) of prominent cervical lateral alae. Furthermore, *V. potekhina hugoti* (without lateral alae) can be differentiated from the first group of species according to some ecological characteristics (geographical distribution and specificity). Thus, the species that show higher affinity with our specimens are *V. potekhina* and *V. grimaldiae*.

The Iberian specimens resembles *V. grimaldiae* in the small projection present at the caudal

extremity of males (Fig. 3). This could be related to the fact that *V. grimaldiae* is the species most closely located to the Iberian Peninsula. However, *Vigisospirura potekhina hugoti* can be differentiated from it by the different sizes of its spicules. *V. grimaldiae* male spicules are $1,450 \times 17 \mu\text{m}$ and $1,260 \times 10 \mu\text{m}$ (spicular relationship 1:1.15); *V. potekhina hugoti* are $955 \times 20 \mu\text{m}$ and $885 \times 13 \mu\text{m}$ (spicular relationship 1:1.07). Furthermore, *V. grimaldiae* shows a high specificity and only parasitizes *Vulpes vulpes* (Carnivora: Canidae) in its geographical distribution (Chabaud, 1959; Bernard, 1968).

The main differences between *V. potekhina* and the new subspecies are in the male sexual structures (spicule size and gubernaculum morphology). Regardless of size of helminths and host infected, size of spicules has been constant in the individuals studied (within a narrow range) (Table 1). The 2 spicules of *V. potekhina hugoti* (Table 2) are larger and more homogeneous in size than those of *V. potekhina* (right spicule: $556 \mu\text{m}$; left spicule: $684 \mu\text{m}$; ratio 1:

Table 2. Comparative morphometry (in micrometers) of *Vigisospirura potekhina hugoti* subsp. n. and *V. potekhina*.

	Males				Females		
	Species: Host: Chorology: Reference: Sample:	<i>V. potekhina</i> <i>Lynx rufus</i> Tadzhikistan and U.S.A. Wong et al. (1980) <i>n</i> = 10	<i>V. p. hugoti</i> <i>Meles meles</i> Spain Present study <i>n</i> = 8 paratypes		<i>V. potekhina</i> <i>L. rufus</i> Tadzhikistan and U.S.A. Wong et al. (op cit.) <i>n</i> = 10	<i>V. p. hugoti</i> <i>M. meles</i> Spain Present study <i>n</i> = 1 para- type	
	Range	Mean	Range	Mean	Range	Mean	Value
Body length	12,300–24,600	18,900	11,847–19,762	15,869.0	24,900–44,100	32,400	21,512
Maximum body width	300–550	411	227–440	333.7	400–850	656	750
Depth buccal capsule	40–55	48	26–34	28.6	50–72	57	33
Width buccal capsule	22–42	27	18–26	22.3	30–70	42	31
Deirids*	240–330	290	206–295	251.6	260–430	363	385
Nerve ring*	290–460	384	266–373	316.5	440–500	450	341
Excretory pore*	330–510	460	367–468	417.9	370–690	537	514
Esophagus							
Total length	7,400–11,900	9,500	5,863–8,824	7,612.2	9,800–16,000	12,000	8,968
Muscular length	420–630	517	372–534	461.7	460–770	639	493
Glandular length	6,900–11,300	9,000	5,491–8,299	7,150.2	9,400–15,300	11,300	8,475
Body length** (%)	48.4–60.1	50.3	44.6–51.7	48.2	36.3–39.4	37.0	41.7
Right spicule	370–660	556	855–917	884.7	—	—	—
Left spicule	510–790	684	928–990	957.6	—	—	—
Ratio of spicules**	1:1.23		1:1.07		—	—	—
Gubernaculum							
Length	65–90	68	72–82	76.3	—	—	—
Maximum width	20–50	29	59–82	68.8	—	—	—
Vulva*					10,800–22,600	16,500	10,934
Body length** (%)	—	—	—	—	43.3–51.2	50.9	50.8
Tail	350–540	432	202–283	230.0	270–400	336	326
Eggs (length)	—	—	—	—	45–58	51	46–57
Eggs (width)	—	—	—	—	28–31	29	26–33

* Distance from anterior extremity.

** Value calculated by us.

1.23). The gubernaculum of the new subspecies shows a characteristic morphology (Fig. 5); it is alate and wider than that of *V. potekhina*.

One of the hosts of *V. potekhina* is *Meles meles*; there is but a single report of this parasite, and it comes from Asia. No reports of this parasite exist in Europe to date, but there are several extensive studies on the helminth fauna of this mustelid on the whole continent (Hancox, 1980 [data collection]; Loos-Frank and Zeyhle, 1982; Brglez, 1988). Other helminth faunistic studies are being performed on most wild peninsular carnivores and no species of the genus *Vigisospirura* are being found. The number of hosts studied to date is up to 1,426 individuals

(206 canids, 875 mustelids, 68 felids, and 277 viverrids) (Miquel, 1993; Motjé, 1995).

Although the spicules of our specimens differ clearly from those of *V. potekhina* in size, the creation of a new species does not appear to be justified. There is no marked morphological difference between the Iberian specimens and *V. potekhina*. On the basis of the relictual characteristics of the Iberian Peninsula, the origin of the new subspecies could be the same as that of other parasites endemic to the peninsula (Hugot and Feliu, 1990). With the present distribution of *V. potekhina* in the holarctic region, the new subspecies may have originated in its main host (*M. meles*) as a consequence of the peculiar

paleobiogeographic characteristics of the Iberian Peninsula.

Key to the Species of *Vigisospirura*

- 1—(5) With prominent cervical lateral alae 2
- 2—(1) Parasitizing Canidae and Felidae in the Soviet Union *V. skrabini*
- 3—(2) Parasitizing Mephitinae in the United States *V. itascensis*
- 4—(3) Parasitizing Viverridae in South Africa *V. whitei*
- 5—(1) Without cervical lateral alae 6
- 6—(5) Right and left spicules $>1,250\ \mu\text{m}$; ratio of spicules 1:1.15; tail of male ends in a small projection; parasitizing Canidae in North Africa *V. grimaldiae*
- 7—(6) Right and left spicules $<1,250\ \mu\text{m}$; tail of male ends with or without small tail projection 8
- 8—(7) Right and left spicules $<800\ \mu\text{m}$; ratio of spicules 1: >1.2 ; without small tail projection; parasitizing Felidae and Melinae (experimentally also Canidae) in the United States and Tadzhikistan Republic *V. potekhina potekhina*
- 9—(8) Right and left spicules between 850 and $1,000\ \mu\text{m}$; ratio of spicules 1: <1.1 ; with small tail projection; parasitizing only *Meles meles* in the Iberian Peninsula. *V. potekhina hugoti* subsp. n.

Acknowledgments

The study was partially supported by the "Comissionat per Universitats i Recerca de la Generalitat de Catalunya" (GRQ 94-105) and Spanish DGICYT project PB 92-0517-CO2-02. We thank the "Serveis Científic-Tècnics" of the University of Barcelona for his aid and support in the preparation of the SEM micrographs.

Literature Cited

- Bernard, J.** 1968. Cas de parasitisme intense chez un renard saharien. Archives Institute Pasteur de Tunis 45:153-168.
- Brglez, J.** 1988. Some endohelminths in badgers, *Meles meles* L., in Slovenia. Zbornik Biotehniške Fakultete Univerze Edvarda Kardelja v Ljubljani, Veterinarstvo 25:251-257.
- Chabaud, A. G.** 1959. Sur la systématique des nématodes proche de *Spirocerca lupi* (Rud. 1809). Parasitologia 1:129-135.
- Hancox, M.** 1980. Parasites and infectious diseases of the Eurasian badger (*Meles meles* L.): a review. Mammal Review 10:151-162.
- Hugot, J. P., and C. Feliu.** 1990. Description de *Syphabulea mascomai* n. sp. et analyse du genre *Syphabulea*. Systematic Parasitology 17:219-230.
- Loos-Frank, B., and E. Zeyhle.** 1982. The intestinal helminths of the red fox and some other carnivores in southwest Germany. Zeitschrift für Parasitenkunde 67:99-113.
- Miquel, J.** 1993. Contribución al conocimiento de la helmintofauna de los Carnívoros silvestres de Cataluña. Ph.D. Thesis, University of Barcelona, Barcelona.
- , **J. C. Casanova, F. Tenora, C. Feliu, and J. Torres.** 1995. A scanning electron microscope (SEM) study of some Rictulariidae (Hall, 1915) from Iberian mammals. Helminthologia 32:3-14.
- Motjé, M.** 1995. Contribución al conocimiento de la helmintofauna de la familia Mustelidae (Carnivora) en la Península Ibérica. Ph.D. Thesis, University of Barcelona, Barcelona.
- Prokopic, J., and D. Hulínská.** 1983. Scanning electron microscopic study of the superficial cuticle of the nematodes *Heligmosomum costellatum* (Dujardin, 1845) and *H. mixtum* Schulz, 1954. Folia Parasitologica 30:27-29.
- Sanmartín, M. L., F. Alvarez, H. Gijón-Botella, R. Iglesias, J. Estevez, and R. López-Román.** 1992. A scanning electron microscope study of *Toxocara genettae* Warren, 1972 (Ascaridae), with data of morphometric variation. Folia Parasitologica 39:255-367.
- Wong, P. L., T. Watson, and R. C. Anderson.** 1980. *Vigisospirura potekhina* (Petrov and Potekhina, 1953) (Nematoda: Spiruroidea) from the bobcat, *Lynx rufus* (Schreber) in the southeastern USA. Canadian Journal of Zoology 58:1612-1615.